

Short Communication

Punjab Sona Cherry and Punjab Kesar Cherry- Varieties of cherry tomato for naturally ventilated polynet house cultivation

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Protected cultivation provides good quality, safe produce to the consumers in view of the less quantity of pesticides used as compared to the open field conditions (Cheema et al. 2013). To increase productivity of good quality fruits, the Punjab Agricultural University (PAU), Ludhiana, India has recommended protected cultivation of the tomato in the state from 2005. The technology has been widely adopted by the state growers. Two indeterminate varieties of table tomato suitable for protected cultivation namely 'Punjab Gaurav' and 'Punjab Sartaj' have been recommended for commercial cultivation in the State by PAU (Jindal and Dhaliwal 2016). There is another segment called cherry tomato which is considered a high value crop. Cherry tomatoes (*Solanum lycopersicum* var. *cerasiforme*) are known as tasty, numerous small size fruits in clusters along the stem and branches of the plants. Cherry tomatoes are grown for its edible fruits which can be consumed fresh as salads. Cherry tomato is a storehouse of carotenoids (lycopene and carotene), ascorbic acid and phenolics, thus, they are sold at a premium price in many of the large retail stores in the country. Although cherry tomatoes have more nutritional values as compare to normal tomatoes, but work done on quality improvement of cherry tomatoes is scanty. There was no breeding programme targeted towards cherry tomato and specifically for nutritive values/quality in India. Therefore, there is a need for development of high yielding varieties or hybrids with high nutritive value. In view of this, Punjab Agricultural University, Ludhiana has started work on cherry tomato and developed first

cherry tomato variety namely 'Punjab Red Cherry' from interspecific cross between *Solanum lycopersicum* and *S. pimpinellifolium*. The variety was thus recommended for polyhouse tomato growers of the state (Dhaliwal and Jindal 2017). The development of red coloured cherry tomato variety resulted in creating awareness regarding quality among tomato growers, thus, in turn demand for cherry tomatoes of other colors like yellow, orange, pink, purple, etc was increased in the state. Therefore, focusing on quality, two cultivars 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' were developed following single plant selection method from a segregating population collected from farmers' field. The varieties were improved by continuous selfing (more than 6 generations) by selecting individual plant from the original population. In earlier generations, individual plant selections was based on yield and yield attributing traits, earliness in fruit harvesting, fruit firmness, TSS and fruit colour responsible for carotene content. The finally selected material were evaluated for the fruit quality traits dry matter, lycopene content, titrable acidity, total carotenoids and ascorbic acid; and reaction to diseases and insects. The final selection with pedigree 'CT-F₂-11-24-5-1-1' and 'CT-F₂-8-14-3-1-1' was named 'Punjab Sona Cherry' and 'Punjab Kesar Cherry', respectively. The yellow fruit color of 'Punjab Sona Cherry' and orange fruit color of 'Punjab Kesar Cherry' making these varieties for use where additional flavour or retinoid activity is desired. Stommel et al. (2005) also demonstrated the importance of color on consumer perceptions of fruit quality. Based on the field performance and due to the importance of carotene content in human diet, these varieties were released by Punjab State Varietal Approval Committee for commercial cultivation in the state.

'Punjab Sona Cherry' and 'Punjab Kesar Cherry' were evaluated with comparison to the previously released

variety 'Punjab Red Cherry' in on-station trials at PAU, Ludhiana, over 3 years in 2013-2014, 2014-15 and 2015-2016; in multi-location trials at 8 locations throughout the state of Punjab in 2014-15; and in on-farm trials at 15 locations in 2015-16. However, these two new varieties and the check 'Punjab Red Cherry' were also tested along with orange coloured hybrid 'Sheeja' from *Known Your Seed Private Limited* in on-station and in on-farm trials during 2015-16 as the hybrid 'Sheeja' was available in the market for commercial cultivation during 2015-16. On-station and multi-location trials were replicated in a randomized complete block design and the data were analyzed using standard analysis of variance. On-farm trials were not replicated. The experiments were conducted in a naturally ventilated, un-heated, polyhouse. Seed were sown in first week of September on well prepared nursery beds and seedlings were transplanted after 25-30 days of sowing into polyhouse, on single sides of 3m-long beds with plant-to-plant and row-to-row distance of 30 and 90 cm, respectively. Plants were trained vertically retaining 3-4 shoots per plant. The varieties 'Punjab Sona Cherry', 'Punjab Kesar Cherry', 'Punjab Red Cherry' and the hybrid check 'Sheeja' were evaluated for early yield (q/ha), total yield (q/ha), fruit weight (g), days to harvest, number of fruits per cluster, number of clusters per plant, cluster weight (g), fruit shape index (P/E

diameter), pericarp thickness (mm), number of locule per fruit, dry matter (%), total soluble solids (TSS, °Brix), acidity (mg/ 100 ml juice), ascorbic acid (mg/ 100ml juice), total carotenoids (mg/100g), lycopene content (mg/ 100g), physiological weight loss (%), fruit firmness (measured with penetrometer, lb force), shelf life in days, late blight (% disease index), root gall index (0- 5 scale), leaf curl virus (% incidence), percent fruit damage by *Heliothis armigera*, number of aphid and whitefly population present per 50 leaves. The disease data on late blight, root gall index and leaf curl virus under artificial conditions was recorded as per the method given by Thind et al. (1989), Taylor and Sasser (1978) and Muniyappa et al. (1991), respectively whereas the data on per cent fruit damage, number of aphid and whitefly was recorded under open field conditions in non-sprayed conditions. However, the performance of 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' is based on the overall mean obtained from the 3 levels of evaluation trials under polytunnel house conditions.

Performance of cherry tomato varieties for yield and fruit traits: Yield and fruit traits of 'Punjab Sona Cherry', 'Punjab Kesar Cherry', 'Punjab Red Cherry' and hybrid check 'Sheeja' in on-station, multi-location and on-farm trials were varied. 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' produced early yield of 338.32 q

Table 1: Performance of cherry tomato varieties at On-station research, multi-location and On-farm trials

Variety	On-station trials (mean of 3 years)	Multi-location trials (mean of 8 locations)	On-farm trials (mean of 15 locations)	Overall mean
Days from transplanting to first picking				
Punjab Sona Cherry	110.67	111.69	114.00	112.12
Punjab Kesar Cherry	113.34	115.09	115.15	114.53
Punjab Red Cherry (check)	117.59	118.21	117.54	117.78
Sheeja (check hybrid)	104.67	-	108.46	106.57
CD at p=0.05	1.42	2.74	1.94	-
Fruit weight (g)				
Punjab Sona Cherry	10.71	11.24	10.99	10.98
Punjab Kesar Cherry	11.94	10.77	11.44	11.38
Punjab Red Cherry (check)	11.66	11.42	12.01	11.70
Sheeja (check hybrid)	09.67	-	09.79	09.73
CD at p=0.05	1.27	0.65	1.15	-
Early Yield (qha ⁻¹)				
Punjab Sona Cherry	338.32	375.78	392.17	368.76
Punjab Kesar Cherry	319.05	367.34	344.44	343.61
Punjab Red Cherry (check)	360.09	405.42	345.28	370.26
Sheeja (check hybrid)	388.67	-	366.11	377.39
CD at p=0.05	13.12	22.34	18.72	-
Total Yield (qha ⁻¹)				
Punjab Sona Cherry	1058.95	1067.80	1056.57	1061.11
Punjab Kesar Cherry	1021.00	994.62	1002.90	1006.17
Punjab Red Cherry (check)	1106.93	1068.63	1084.33	1086.63
Sheeja (check hybrid)	1165.00	-	1180.27	1172.64
CD at p=0.05	103.45	107.68	111.14	-

ha⁻¹ and 319.05 q ha⁻¹ in on-station trials, 375.78 q ha⁻¹ and 367.34 q ha⁻¹ in multi-location trials and 392.17 q ha⁻¹ and 344.44 q ha⁻¹ in on-farm trials compared to 360.09 q ha⁻¹, 405.42 q ha⁻¹ and 345.28 q ha⁻¹ by 'Punjab Red Cherry'. The hybrid 'Sheeja' produced early yield of 388.67 q ha⁻¹ and 366.11 q ha⁻¹ in on-station and on-farm trials. Thus, both test varieties have lower yield than the checks at three levels of testing. While, 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' matured earlier than the check variety 'Punjab Red Cherry' but matured late than the check hybrid 'Sheeja' (Table 1). Total yield of 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' in on-station and on-farm trials were less than 'Punjab Red Cherry' and the hybrid 'Sheeja'. 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' produced more fruits per cluster, cluster weight and clusters per plant over the 'Punjab Red Cherry' whereas less than the hybrid 'Sheeja'. Overall, fruit weight of both the test entries and the hybrid 'Sheeja' was less than 'Punjab Red Cherry'. Dhaliwal and Jindal (2017) reported higher fruits per cluster, clusters per plant, cluster weight and less fruit weight in 'Punjab Red Cherry' than the check 'NDT-9'. Commercially acceptable fruit size of cherry tomato range between 10-15 g of which all the test and check entries fruit conform. Fruit shape index (polar/equatorial diameter) of 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' was more than 1.1, indicating an oval fruit shape (Table 2). Shape of cherry tomatoes is oval, round, oblong, pear or cylindrical, but oval fruit is attractive and liked by consumers. The pericarp thickness of 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' was less than the hybrid 'Sheeja' (Table 2). All the entries had two locules per fruit (Table 2). A thicker

pericarp and fewer locules impart firmness to tomato fruit, enhancing shelf-life and transportability (Jindal et al. 2015).

Performance of cherry tomato varieties for quality traits:

Dry matter, TSS and total carotenoid contents of 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' were higher than 'Punjab Red Cherry' and the hybrid 'Sheeja' (Table 2) but lycopene content of test entries was lower than the checks. The higher TSS content of 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' contributes to sweetness. The yellow colour of 'Punjab Sona Cherry' and orange colour of 'Punjab Kesar Cherry' making the fruit more attractive is due to high carotenoid content (Table 2). Stommel (2005) developed USDA 02L1058 and 02L1059, two orange coloured cherry tomato lines with high fruit carotene content. Acidity content of both test entries was high than 'Punjab Red Cherry' but less than 'Sheeja'. However, ascorbic acid contents of all the entries were comparable (Table 2). Fruit firmness, another important quality parameter, is closely associated with ripeness stage. Most consumers prefer firm fruits which do not lose too much juice when sliced and which do not have tough skins. Firmness affects susceptibility of tomatoes to physical damage and consequently their shipping ability (Raffo et al. 2002). The textural quality of tomatoes is influenced by skin toughness, flesh firmness, and internal fruit structure which vary greatly among cultivars. Both the varieties 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' exhibited better firmness than check (Table 2). Physiological weight loss of fresh tomatoes is primarily due to transpiration and respiration and it can influence the economic returns. 'Punjab Sona Cherry' and 'Punjab

Table 2: Performance of cherry tomato varieties for important fruit and quality traits* under poly-net house

Variety	Traits	Punjab Sona Cherry	Punjab Kesar Cherry	Punjab Red Cherry (check)	Sheeja (check hybrid)	CD at p=0.05%
	Number of fruit per cluster	21.92	19.67	18.96	25.67	3.42
	Number of clusters per plant	19.79	18.75	19.64	20.77	1.34
	Cluster weight (g)	180.4	167.0	165.7	193.7	11.26
	Fruit shape index (P/E)	1.16	1.14	1.05	1.13	0.04
	Pericarp thickness (mm)	2.04	2.40	2.32	2.58	0.23
	Number of locules per fruit	2.00	2.00	2.00	2.00	NS
	Plant height (cm)	444.6	401.0	404.2	389.3	22.67
	Dry matter (%)	6.88	7.99	6.93	7.25	0.94
	TSS (°Brix)	7.48	7.56	6.28	7.45	0.53
	Acidity (g per 100 ml of juice)	0.70	0.70	0.49	0.86	0.11
	Vitamin C (g per 100 ml of juice)	31.25	32.30	30.99	24.49	3.12
	Lycopene (mg per 100 g FW)	0.20	1.81	5.18	0.97	0.31
	Total carotenoids (mg per 100 g FW)	13.03	12.81	05.60	12.78	1.51
	Physiological loss in weight (%)	5.35	5.23	5.61	7.73	0.63
	Firmness (lb force)	4.00	4.07	3.74	3.97	0.55
	Shelf life (days)	5.0	5.5	4.5	4.0	-

*average of 2 years, FW: Fresh weight

Table 3: Reaction of cherry tomato varieties against important diseases (under artificial inoculation conditions) and insect-pests (under natural conditions)*

Variety	Late blight, % disease index	Root gall index, (0- 5 scale)	Leaf curl virus, % incidence	Percent fruit damage by <i>H.</i> <i>armigera</i>	No. of white flies per 50 leaves	No. of aphids per 50 leaves
Punjab Sona Cherry	33.5 (MS)	3.3 (S)	57.5 (MI)	3.04	1.50	6.25
Punjab Kesar Cherry	31.6 (MS)	2.8 (MS)	62.5 (MI)	2.00	2.00	6.50
Punjab Red Cherry (check)	36.1 (MS)	3.3 (S)	47.5 (MI)	1.60	1.25	7.25
Sheeja (check hybrid)	11.0 (MR)	3.2 (S)	65.0 (MI)	2.00	3.00	7.50

*average of 2 years; Where, S-Susceptible, MS-Moderately susceptible, MR-Moderately resistant and MI-Moderate infection

Kesar Cherry' had less physiological loss (Table 2) which was 5.35% and 5.23% when compared with 'Punjab Red Cherry' (5.61%) and 'Sheeja' (7.73%). Better shelf-life of 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' was evident from the physiological weight loss and fruit firmness (Table 2).

Reaction of cherry tomato varieties against insect-pests and diseases: Resistance of cherry varieties to late blight, root knot nematodes (RKN) and leaf curl virus (LCV) diseases was evaluated by artificial inoculation method (Table 3). Against late blight the disease score of 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' was less than 'Punjab Red Cherry' but higher than the hybrid 'Sheeja'. Both varieties had susceptible reactions to late blight and 'Sheeja' was moderately tolerant when artificially inoculated. The disease score of 'Punjab Sona Cherry', 'Punjab Kesar Cherry', 'Punjab Red Cherry' and 'Sheeja' was comparable for root knot nematodes and leaf curl virus under natural disease and artificial inoculated conditions (Table 3). The score of percent fruit damage of 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' is slightly higher than the checks under natural field conditions (Table 3). More damage by insect might be due to high sweetness or attractive color of the test entries. The number of aphids and white fly per 50 leaves under natural conditions were comparable in all the entries tested. Both varieties 'Punjab Sona Cherry' and 'Punjab Kesar Cherry' are documented with National Bureau of Plant Genetic Resources, New Delhi having accession code 'IC 619412' and 'IC 619413', respectively.

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